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About the Cover

The X-29 forward swept wing aircraft made its maiden flight on Dec. 14, 1984, at Ames Research Center's Dryden Flight Research Facility at Edwards, Calif. With Grumman Aerospace chief test pilot Charles A. (Chuck) Sewell at the controls, the aircraft was flown to an altitude of 15,000 feet. The top speed of the 58-minute flight (during the climb) was 235 knots. The flight was the first in an initial series of four to be flown by Grumman Aerospace Corp., manufacturer of the airplane.

Major objective of the flight was to functionally check out various systems on the aircraft including its flight control and environmental control systems. All systems performed as planned.

Following successful checkout flights, the X-29 will be turned over to NASA for flight envelope expansion by government and contractor pilots starting this month.

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NASA May Fly By Asteroid With Galileo Spacecraft

NASA Administrator James M. Beggs has approved the addition of an asteroid flyby option to the Galileo mission and to change the Jupiter arrival date from August to December 1988. The option will permit a post-launch decision to fly by the asteroid 29 Amphitrite in December 1986.

The approval follows two years of study by numerous scientific groups, mission designers and program officials to devise a means to include the option. If the option is elected (a decision will be made after launch) it would add a significant scientific "first" into the Galileo mission.

The Galileo mission to Jupiter, designed to orbit the planet and send an instrumented probe into its atmosphere, is scheduled for a May 1986 launch by the Space Shuttle and a Centaur upper stage.

The National Academy of Sciences, as well as NASA's Solar System Exploration Committee (SSEC), has identified the investigation of the asteroids by spacecraft as an essential element of a balanced planetary exploration program.

The flyby has the endorsement of the Galileo Project Science Group and the Small Bodies Working Group of the SSEC.

The asteroid flyby will be treated as an add-on, not a primary mission objective, and will not be permitted to compromise the basic mission objectives nor add any risk to the already ambitious planetary mission.

A decision to exercise the flyby option will be made after launch, based on an assessment at that time of the health of the spacecraft, particularly the attitude control system and the mission operations system.

Amphitrite is in a near-circular solar orbit in the middle of the asteroid belt at 2.5 Astronomical units (AU) from the sun (the Earth's distance is one AU or about 150,000,000 kilometers). Amphitrite, about 200 km in diameter, is one of the larger of the minor planets.

The flyby distance will be determined by spacecraft safety considerations. A specially convened Hazards Workshop has concluded that with a 10,000 to 20,000-km flyby distance, the hazard to the Galileo spacecraft is no greater than merely flying through the asteroid belt as has been done by two Pioneer and two Voyager spacecraft. Significant scientific objectives can be realized by analyzing measurements and Doppler tracking data obtained from that distance.

From Earth, Amphitrite appears as the twelfth brightest asteroid and has fluctuations suggesting a rotation period of 5.39 hours. At that rotation rate, most of the surface can be photographed and scanned by Galileo's mapping spectrometer. Analysis of these data will reveal its size, shape, mass and density; its exact rotation rate and pole orientation; and its detailed surface morphology and mineral composition. Together, these properties will allow scientists to determine whether Amphitrite is a primitive accumulation of solar nebulae condensates or whether it is an evolved body that is a fragment, or perhaps a core, of a broken-up minor planet.

Information obtained will make it possible to confirm or refute a hypothesis that Amphitrite and other asteroids are sources of many of the meteorites which fall on Earth.

This first encounter with an asteroid will also supply ground truth for interpreting many previous and forthcoming ground-based observations of other asteroids.

Amphitrite, the 29th asteroid discovered, was detected by Albert Marth, in London, at the William Bishop Observatory on March 1, 1854. The asteroid was named by Bishop for sone of the mythical god Neptune's wives.

A new trajectory, containing both Amphitrite and Jupiter and constrained by the launch vehicle energy and existing launch window, has been developed. The trajectory will result in a delay in the Jupiter arrival date from Aug. 29, 1988, to Dec. 10, 1988. No mission operations work or added software capability related to the flyby will be accomplished prior to launch other than that required to plan the primary mission based on the asteroid flyby trajectory.

The effect on the Jupiter mission will be minor. Since the flyby requires added expenditure of propellant in the early mission phase, the number of tour orbits of Jupiter would be decreased from 11 to 10. Consequently, the length of the tour has been extended from 20 months to 22 months to permit the achievement of all the major objectives previously encompassed by the 11-orbit tour.

There will be no near-term cost impact due to the incorporation of the flyby option. Major added costs, estimated at $20-$25 million, are attributable to a five-month mission extension due to the delayed arrival date and increased tour time.

The Galileo project is managed by the Jet Propulsion Laboratory, Pasadena, Calif., under the direction of the Office of Space Science and Applications, NASA Headquarters, Washington, D.C.

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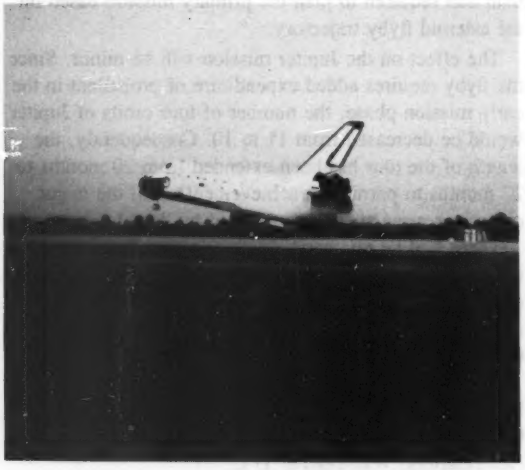
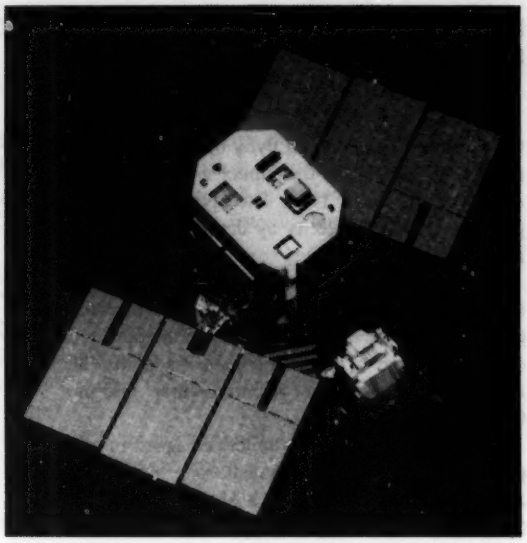
Highlights of 1984 Activities

Date	Event
Jan. 25	NASA directed by President Reagan (in State of the Union message) to develop the Space Station.
Feb. 3	Launch of STS 41-B (Challenger): Vance Brand, Robert L. Gibson, Bruce McCandless II, Robert L. Stewart, Ronald E. McNair.
Feb. 3	Deployment of Westar VI (Western Union communications) from STS 41-B; due to PAM-D malfunction, failed to reach geosynchronous orbit.
Feb. 4	Hubble Space Telescope operations control center dedicated at Goddard Space Flight Center.
Feb. 6	Deployment of Palapa B-2 (Indonesian communications) from STS 41-B; due to PAM-D malfunction, failed to reach geosynchronous orbit.
Feb. 7	Astronaut Bruce McCandless performed first untethered spacewalk using Manned Maneuvering Unit backpack (STS 41-B).
Feb. 11	First Shuttle landing at Kennedy Space Center (STS 41-B).
Feb. 23	Series of three rockets launched for atmospheric studies (Super-Arcas, Viper Dart, Nike-Orion) from Wallops Flight Facility.
March 1	Launch of Landsat 5; NOAA Earth observation (Delta, WSMC).
April 6	Launch of STS 41-C (Challenger): Robert L. Crippen, Francis R. Scobee, George D. Nelson, Terry J. Hart, James D. van Hoften; Solar Maximum Repair mission; Edwards AFB landing, April 13.
April 7	Deployment of Long Duration Exposure Facility (LDEF) from STS 41-C.

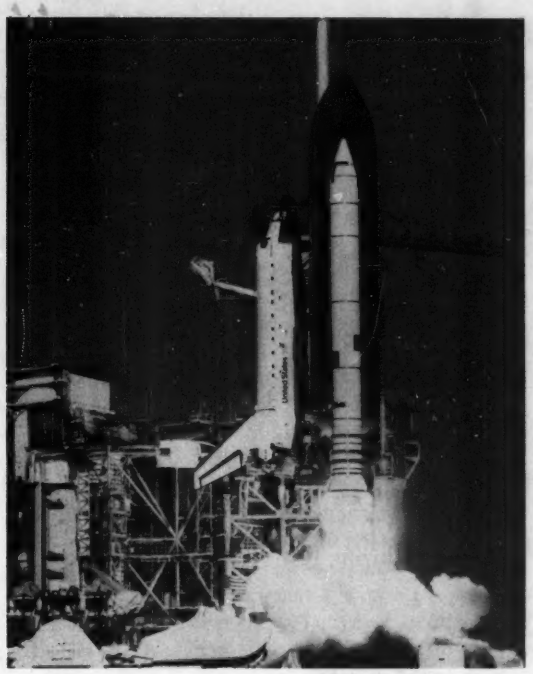


Orbiter Challenger (STS 41-B) makes first Shuttle landing at Kennedy Space Center.



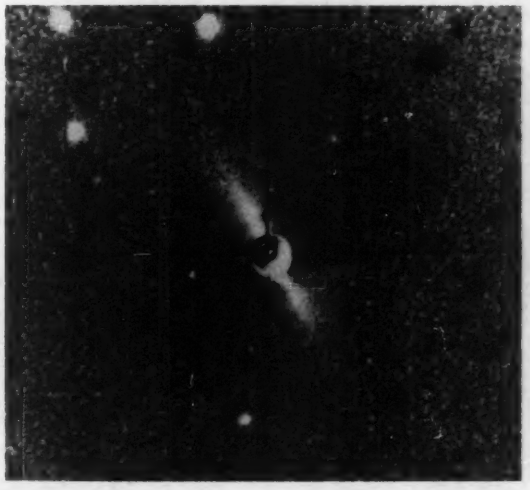
Astronaut George D. Nelson inspects Solar Max satellite during the spacecraft's repair mission (STS 41-C).

May 1	Goddard Space Flight Center, Greenbelt, Md., 25th anniversary.
May 10	Two-stage sounding rocket launched to conduct upper atmosphere wave-plasma experiments (Nike-Orion, WFF).
May 12-Nov. 11	Orbiter Enterprise on display at Louisiana World Exposition in New Orleans.
May 18	Ownership of Viking 1 lander transferred to National Air and Space Museum, marking the first object on another planet to be owned by a museum.
May 23	Group 10 astronaut candidates selected.
June 9	Launch of Intelsat V-G; Intelsat communications (Atlas Centaur, ESMC).
July 27	Space Station Office established (Philip E. Culbertson, Associate Administrator).
July 28-Aug. 4	NASA participation, 32nd Annual Experimental Aircraft Assoc. Convention and Fly-In, Oshkosh, Wisc.
Aug. 16	Launch of Active Magnetospheric Particle Tracer Explorer (AMPTE); joint U.S., British and German space physics mission (Delta, ESMC).
Aug. 27	President Reagan announces first citizen observer in space will be a teacher.
Aug. 27	Launch of STS 41-D (first flight of Discovery): Henry W. Hartsfield, Jr., Michael L. Coats, Judith A. Resnik, Steven A. Hawley, Richard M. Mullane, Charles D. Walker (first commercial payload specialist); Edwards landing, Sept. 5.
Aug. 30	Deployment of SBS-D; Satellite Business Systems communications, from STS 41-D.



Orbiter Discovery begins maiden voyage (STS 41-D).

Aug. 31	Deployment of Leasat (Syncom IV-2); Hughes communications satellite leased to U.S. Navy, from STS 41-D.
Sept. 1	Deployment of Telstar 3-C from STS 41-D; AT&T communications.
Sept. 10	International Solar Polar Mission (ISPM) renamed "Ulysses."
Sept. 11	Commercial Programs Office established (Isaac T. Gillam IV, Assistant Administrator).
Sept. 14	RFP issued to U.S. industry for definition and preliminary design of Space Station.
Sept. 21	Launch of Galaxy-C; Hughes commercial communications (Delta, ESMC).
Sept. 25-Sept. 26	NASA Symposium on Quality and Productivity, Washington, D.C.
Oct. 5	Launch of STS 41-G (Challenger): Robert L. Crippen, Jon A. McBride, Kathryn D. Sullivan, Sally K. Ride, David D. Leestma, Marc Garneau (Canadian payload specialist), Paul D. Scully-Power (civilian oceanographer with U.S. Navy); KSC landing, Oct. 13.
Oct. 5	Deployment of Earth Radiation Budget Satellite (ERBS) from STS 41-G.
Oct. 10	Kathryn D. Sullivan is first American woman to walk in space (STS 41-G).
Oct. 10	NASA-JPL/University of Arizona astronomers announce first photographs of the rings of Uranus.
Oct. 15	NASA-JPL/University of Arizona astronomers announce photographic evidence of possible solar system around Beta Pictoris, a star 50 light years away from Earth.
Oct. 21	First Space Shuttle external fuel tank for use at Vandenberg AFB, Calif., arrived via barge from Michoud Assembly Facility in New Orleans.
Oct. 29	NASA's oldest aircraft, all metal, twin-engine C-47, retired at Dryden Flight Research Facility.
Nov. 1	Hubble Space Telescope optics arrive at Lockheed Missiles & Space Co., Sunnyvale, Calif., for integration with other components, from Perkin-Elmer Corp., Danbury, Conn.
Nov. 8	Launch of STS 51-A (Discovery): Frederick D. Hauck, David M. Walker, Anna L. Fisher, Joseph P. Allen, Dale A. Gardner; KSC landing, Nov. 16.
Nov. 9	Deployment of Telesat-H (Anik); Canadian communications, from STS 51-A.
Nov. 10	Deployment of Leasat (Syncom IV-2); Hughes communications satellite leaded to U.S. Navy, from STS 51-A.
Nov. 12	Retrieval of Palapa B-1 by STS 51-A crew.
Nov. 13	Launch of NATO III-D; North Atlantic Treaty Organization communications (Delta, ESMC).
Nov. 14	Retrieval of Westar IV by STS 51-A crew.
Dec. 1	Begin Teacher in Space application period (thru Feb. 1, 1985).
Dec. 12	Launch of NOAA-F; climate survey and weather (Atlas-F, WSMC).
Dec. 14	First flight of X-29 forward swept wing aircraft at DFRF, Edwards, Calif. (Charles A. Sewell, Grumman Aerospace, pilot).
Dec. 27	AMPTE artificial comet experiment, 4:32 a.m. PST.



The circumstellar disk of material extending 40 billion miles from the star, Beta Pictoris, may be another solar system 50 light years away.

IRAS Astronomical Catalog Available

The largest and most detailed catalog of infrared celestial objects ever created has been completed by the international science team of the Infrared Astronomical Satellite (IRAS). The completion of the IRAS survey, presented in a series of catalogs and maps of 96 percent of the entire sky, is a milestone in the history of astronomy, and provides a wealth of new information about the universe in a wavelength region that is nearly impossible to study from the Earth's surface.

The IRAS catalog pinpoints nearly a quarter-million infrared sources — stars, galaxies and newly forming stars — in addition to entirely new classes of objects. The catalog and sky map will be used for decades to come by astronomers investigating the nature of celestial objects that emit much of their energy in infrared wavelengths, as well as by astronomers seeking to understand objects at other wavelength regions of the electromagnetic spectrum.

IRAS is a joint project of the space agencies of the United States, the Netherlands and the United Kingdom. The telescope satellite was launched Jan. 25, 1983, and conducted a 10-month, all-sky survey of infrared objects from Earth orbit until its supply of liquid helium coolant was depleted Nov. 23, 1983. The project was undertaken to locate and study the many objects that radiate infrared wavelengths.

Some events, such as the birth and death of stars and the condensation of planetary systems, are best observed through infrared instrumentation. Earth's atmosphere, however, blocks almost all infrared radiation, so the IRAS telescope was designed to scan the skies from a 560-mile-high orbit far above Earth's obscuring atmosphere.

Preliminary IRAS findings include the discovery of protoplanetary systems — rings of material that may some day form into planets around dozens of nearby stars. IRAS studies of such stars led optical astronomers to examine the objects for the first time and resulted in photographic evidence, released in October, of a possible solar system around the star Beta Pictoris.

The orbiting telescope also found extremely luminous galaxies as powerful as 2 trillion suns, but which emit more than 99 percent of their energy in far-infrared wavelengths. IRAS also found stars like our sun in the process of forming from nearby clouds of interstellar gas, rings of dust in our solar system between the orbits of Mars and Jupiter and cirrus-like clouds of dust and gas that stretch across huge expanses of the sky.

The IRAS catalog contains roughly 130,000 stars, 20,000 galaxies, 50,000 dense condensations within the infrared cirrus and 40,000 objects of all types within the plane of our galaxy, the Milky Way.

The catalog is presented in several formats, including a five-volume book containing 5,000 pages of computer printout information on the location and infrared characteristics of 245,839 individual point sources found by the telescope. The catalog is also available on microfiche (24 cards) and magnetic tape comprising 60 megabytes of data.

For 5,000 of the brightest objects, an onboard spectrometer was able to break down the radiation from the objects into finer detail to obtain spectral information that will help classify the objects.

The atlas of sky maps consists of 212 computer processed color photographs, each covering a two arc-minute region of the sky. These data are also available on magnetic tape and black-and-white and color negatives.

Accompanying the IRAS data collection is an explanatory supplement that tells astronomers how to use the catalog and describes the IRAS instrumentation; the telescope scanning strategy; and sky coverage, data reduction techniques and calibration. It also includes information on the IRAS low-resolution spectrometer instrument and its data.

The catalog and maps, compiled at NASA's Jet Propulsion Laboratory Pasadena, Calif., have been delivered to the following institutions:

National Space Science Data Center (NSSDC)
Code 601.4
Goddard Space Flight Center
Greenbelt, Md. 20771

Huygens Laboratory
University of Leiden
The Netherlands

Rutherford Appleton Laboratory
Chilton, Didcot
Oxfordshire OX11 0QX
United Kingdom

In addition to the point source catalog, IRAS data have been assembled into catalogs listing information for external galaxies and quasars, as well as for small extended sources.

According to IRAS scientists, most of what IRAS saw in its 10 months of observations still lies buried in the reels of computer tape and printouts that contain the IRAS data, unknown even to those most closely involved with the mission. The tapes will serve as an archive to be consulted by astronomers well into the next century, much as the photographic plates from an optical sky survey are used.

Follow-up studies of many interesting objects found in the IRAS survey are already being conducted from ground-based observatories in wavelengths other than infrared, and a limited number of studies are being made with ground-based and airborne infrared instrumentation. But, according to IRAS scientists, the most interesting objects seen by IRAS will have to be studied with spaceborne far-infrared instruments.

At least two more orbiting infrared facilities are planned for the 1990s. The Infrared Space Observatory will be launched by the European Space Agency, and the Space Infrared Telescope Facility will be deployed by NASA from the Space Shuttle.

The IRAS program involved nearly 500 scientists, engineers and technicians from the United States, the Netherlands and the United Kingdom. The satellite was developed and operated by NASA, the Netherlands Agency for Aerospace Programs (NIVR), and the United Kingdom's Science and Engineering Research Council (SERC). The Rutherford Appleton Laboratory in Chilton, Didcot, England, operated the tracking station and preliminary science analysis center. Data processing and compilation of the sky catalog and maps were performed at the Jet Propulsion Laboratory, which manages the project for NASA.

Laminar Air Flow Process Key to Fuel Efficiency

NASA is testing a concept of removing the layer of air molecules next to an aircraft's wing surfaces to increase the flight efficiency of transport aircraft.

During the cruise phase of subsonic flight, approximately one-half of the total drag slowing an aircraft is caused by air/skin friction, resulting in turbulent air flow. The NASA concept, called laminar (air) flow control, uses suction through porous wing surfaces to remove the turbulent air, thus maintaining smooth or laminar air flow and reducing drag and fuel consumption.

Laminar flow control is one of several technologies under study at NASA which promises significant fuel savings for commercial transport operators in the 1990s and beyond.

Two laminar flow control system concepts have been designed and fitted to a NASA JetStar four-engine light transport. The systems are located on the leading edge of each wing and are encased in metallic "gloves" at mid-wing. The gloves are perforated either by more than a million tiny suction holes or by narrow slots.

Lockheed-Georgia Corp., Marietta, Ga., designed the test article installed on the JetStar's left wing. Construction is a sandwich of nomex honeycomb core and graphite epoxy face sheets, covered by a thin sheet of titanium bonded to the surface. Slots in the titanium sheets, a mere four one-thousands of an inch wide, run the length of the section and are the openings that draw air through the surface, through ducts within the wing and into the fuselage.

Douglas Aircraft Co., Long Beach, Calif., designed the test article on the right wing. The Douglas concept, instead of being slotted, was perforated by an electron beam that drilled 800 precise, nearly microscopic holes per square inch of wing surface.

These subtle wing openings are expected to make a tremendous difference in how easily the test airplane slips through the air.

Researchers at NASA's Langley Research Center, Hampton, Va., where the agency's laminar flow control work is managed, point to studies of energy-efficient transports that could be built by the year 2000. One energy-minded transport configuration, already efficient by today's standards, would be 22 percent more efficient with the addition of laminar flow control, according to a Lockheed-Georgia study performed for NASA.

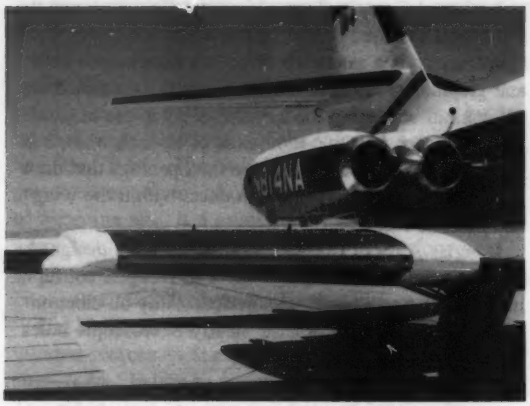
Laminar flow control is not a new concept. Since the 1930s, aerodynamicists have sought to devise a practical system, but the technology has proved elusive. Some systems have reached flight test status, but were judged impractical for operational service.

"We expect our leading edge flight test program to demonstrate that we can get good, maintainable laminar flow," says Langley's Richard D. Wagner, program manager. "Later work will extend the test region to much more of the wing, but it is the leading edge area that represents some of the greatest challenges."

Keeping the surface of these wings smooth and clean is crucial to maintaining laminar flow and is most difficult in the leading edge area, where insects and icing present special problems.

The remains of insects impacted by the wing, near ground level at takeoff and landing, can roughen the surface and clog the suction system. Icing, encountered in weather systems while climbing or descending from altitude, may have a similar effect.

Both concepts have built-in systems for keeping the wing surface clear of insects and ice. The Lockheed system pumps a cleansing fluid to the surface through the slots to make the surface too slippery for insects to easily stick. The fluid is also a freezing point depressant to limit ice build-up.



Douglas concept, on right wing, makes use of tiny perforations on the leading edge and upper wing surface to draw air into the wing. A retractable insect shield is hidden under the wing leading edge.

The Douglas concept uses a retractable insect shield deployed in front of the leading edge panel during takeoff, climb, desent and landing. The extended shield also increases wing lift. When not in use, the shield is stored in the underside of the leading edge box. In return, the Douglas concept sacrifices laminar flow benefits on the underside of the wing.

Wagner sees the dual use of the tiny surface openings as an efficient marriage of leading edge systems. "We don't expect to get laminar flow until the airplane approaches cruise conditions, after clearing the insect and ice zones. That's when we'll stop dispensing fluids and turn on the air suction system," he said.

After the leading edge systems on both test articles are tuned for their best performance, the airplane will be flight tested at various locations around the country at different times of the year to record effects of different weather and insect conditions. The airplane will be flown at cruise altitude on each flight to document the expected laminar flow. These simulated service flights will be conducted during 1985, beginning with Cleveland as home base for a month this winter.

The ultimate objective of the JetStar flight program is to establish a technology base for future industry exploitation of laminar flow technology. The program is a cooperative effort between NASA's Langley Research Center and Ames Research Center's Dryden Flight Research Facility, Edwards, Calif., with industry participation.

Goddard Team Assists in Establishing South Pole Data Link

A six-member team from NASA's Goddard Space Flight Center Greenbelt, Md., is helping to establish the first satellite data link from the South Pole. The link make possible the realtime collection of scientific data from the Pole.

The effort is in support of a joint program with the National Science Foundation (NSF); the Applied Research Laboratory (ARL) of the University of Texas, Austin; the National Oceanic and Atmospheric Administration (NOAA); plus a number of other government, private and educational institutions.

To establish a realtime communications link by any means other than by satellite would cost as much as $35 million, compared with approximately $250,000 via satellite. Goddard engineer Michael Comberiate says, "hard line connections from the Pole have been ruled out. A microwave system of 36 stations across the polar plateau, the crevasse-riddled glaciers, the trans-Antarctic Mountains and the frozen Ross Sea would prove extremely difficult because of the severe winter weather, which brings temperatures of 120 degrees below zero Fahrenheit (–84 degrees centigrade) and winds as high as 200 miles per hour.

"The project could revolutionize communications in the region," explained Comberiate. "Currently, scientific data collected from the Pole during the winter months must be stored and shipped out by aircraft during the Austral Summer" (Nov. 1-Feb. 1).

Comberiate, who developed the idea in 1983 while in the Antarctic as a volunteer systems engineer, will use existing polar-orbiting satellites to relay data from the pole to McMurdo Sound, and re-transmit the data to a geostationary satellite which in turn would transmit the information to the continental United States. This routing must be used because signals from the transmitter at the Pole (90 degrees south latitude) are too far below the horizon to be acquired by a geostationary satellite. The McMurdo station, however, is located on the edge of Antarctica (77 degrees south latitude), and is barely in view of the geostationary orbit.

The link with polar orbiting Landsats 4 and 5, with Dynamics Explorer 1 (DE-1) and with Nimbus 7 will allow reliable transmission of routine, high-volume data from scientific investigations being conducted at the Pole currently by approximately 20 different institutions.

Ham radio communications can be used from the Pole, however, it is not suitable for transmitting scientific data from Antarctica. Two-way back-up voice

link will also be established between the Pole and Goddard using NASA's 17-year-old experimental Applications Technology Satellite (ATS-3)

NSF is providing transportation and travel for the Goddard team, more than five tons of gear and approximately $250,000 in new equipment. The U.S. Geological Survey (USGS) is providing winter-over operators and site planning, and NOAA is providing the use of Landsats 4 and 5, both of which are Earth resources satellites.

The University of Texas' ARL is providing operational personnel at the McMurdo Sound site and assisting in developing the software to run the stations.

Goddard is providing technical expertise for the design, integration, testing and installation of the system in the field.

In addition to Comberiate, other Goddard employees participating in the six-week-long expedition are Anthony Comberiate, communications specialist; Dave Provost, data systems specialist; Mike Lewis, radio technician, Bendix Field Engineering Corp. (BFEC) Columbia, Md.; Dwight Veney, radio equipment repairman, BFEC; and Joel Gallun, software specialist,. OAO Corp., Greenbelt, Md.

Key Personnel Announcements

Gary E. Krier has been named Director of the Commercial Development Division in NASA's new Office of Commercial Programs. **Stanley R. Goldberg** has been named Acting Deputy Director for the division.

Krier began his career with NASA at Ames Research Center's Dryden Flight Research Facility, Edwards, Calif., in 1967 as an aerospace research test pilot and engineer. In this capacity, he directed the Y-17 research program and was the first to fly NASA's digital "fly-by-wire" all-electric flight control system aircraft. From 1979 to 1982, Krier studied law at the University of California, Los Angeles. He served as an attorney in the Office of the Chief Counsel at Ames Research Center, Mountain View, Calif., and in 1983 moved to NASA Headquarters in Washington, D.C., as director of the Aircraft Management Office.

Goldberg joined NASA in 1979 as Chief of the Studies and Economic Analysis Branch. Prior to that, he served as Vice President at Public Technology, Inc., Washington, D.C.

William D. Hager has been appointed Assistant Inspector General for Investigations in the Office of Inspector General at NASA Headquarters. Before joining NASA, Hager was Assistant Section Chief in the Engineering Section at the Federal Bureau of Investigation. He began his government service as a special agent in January 1971. In 1980, he was promoted to Unit Chief, and in January 1981, became Branch Chief in the Engineering Section. He served as Branch Chief until November 1983 when he became Assistant Section Chief. From 1969 to 1971, Hager was a senior engineer at Rockwell International.

Paul F. Holloway has been named Deputy Director of Langley Research Center, Hampton, Va. Prior to this appointment, he was Director for Space at Langley since May 1975. Holloway joined NASA in June 1960 as an aerospace research engineer. Since that time he has held various positions including Acting Deputy Associate Administrator in the Office of Aeronautics and Space Technology at NASA Headquarters, and Chief of the Space Systems Division at Langley.

Clear-Air Turbulence Research Conducted at Ames

New findings by NASA on the nature of high-altitude, clear-air turbulence (CAT) may eventually lead to its prediction and enable pilots to route their airplanes around the invisible swirls of wind.

Aircraft incidents involving clear-air turbulence occur infrequently over the United States and Canada. Hence, the probability that anyone will find himself in this uncomfortable situation is quite small. However, the ability of these wind swirls to cause a jumbo jet to bounce during an otherwise smooth flight is of concern when the turbulence is severe. This also applies to the new generation of smaller executive aircraft now being certified to cruise at high altitudes.

The new findings, based on data gathered from airline flight-data recorders, provide the first detailed description of hazardous clear-air turbulence. This phenomenon is a series of swirls or vortices of air imbedded in upper-level wind streams at altitudes between 35,000 and 40,000 thousand feet. The swirls may range in diameter from 900 to 1,200 ft.

Findings show that a jet traveling at 500 miles per hour flies through a single vortex core in about one second. Within that one second, the plane is pushed upward and then down again. Passengers are pushed into their seats with the weight of an extra G (a measurement of gravity). Those who are not belted in are likely to move toward the ceiling of the plane.

Two to four of these vortices may be encountered in succession about 4 seconds apart. Injuries occur to flight attendants, passengers using the lavatories and children sitting unbelted in adults' laps.

Investigators at NASA's Ames Research Center, Mountain View, Calif., have found that the strongest vortices occur at about 25 miles downwind of large thunderstorms or mountain ranges, which cause a swell in the upper-level wind stream.

NASA airplane dynamics experts Rod Wingrove, Ralph Bach and Rajiv Mehta, in cooperation with the National Transportation Safety Board, are working with aeronautics professor Ted Parks of the University of Arizona and meteorologist Peter Lester of San Jose State University at the Ames Research Center to learn more about the phenomenon.

Pilots have been experiencing hazardous clear-air turbulence at high altitudes since World War II. However, collecting detailed information about it from airline operations has been possible only within the last few years since wide-bodied airliners began to use modern digital flight-data recorders. The NASA team compares the flight-recorder information with that from ground-based air traffic control radar records and weather data. This combination of information has been the key for Wingrove and his team to draw a detailed picture of the hazards of clear-air turbulence.

The team has found that the vortices are formed by wind shears at the tropopause, which is the boundary between the troposphere and the stratosphere. At the tropopause, higher velocity jet streams travel just above lower-speed windstreams. This difference in the speeds of the two wind flows is a form of wind shear.

The investigators have verified that wind shear layers which are pushed up over a thunderstorm or a mountain range act very much like ocean waves when forced to rise over an obstacle.

The air forms a series of swells which turn to waves that curl like the waves on the sea. These short air waves continue to curl until they form complete circles or vortices that whirl at high speeds. These vortices eventually disintegrate as they travel in the wind stream.

Planes flying into the wind have some warning of the disturbances ahead as they begin to encounter the relatively mild turbulence of the dissipating vortices. The airline captain can prepare the passengers and crew by turning on the seat belt signs. However, those traveling with the windstream may encounter the turbulence with little or no warning. As a result of its research, the NASA team hopes one day to be able to give pilots better indications of when and where the vortices may be encountered.

Wingrove and his fellow researchers have gathered their information from five cases in which jumbo jets encountered clear-air turbulence over North America between 1975 and 1983.

The researchers also plan to set up a model of the turbulence on flight simulators at Ames this winter. They will simulate the flight of different types of aircraft through the vortices to see how each size aircraft reacts in turbulence of this kind.

Kennedy Expands ESP to Include Contractors

Top management, use of suggestion program advocates in each organization and prompt, fair evaluations are three important ingredients in the revitalized Employee Suggestion Program (ESP) at Kennedy Space Center, Fla. Additionally, the center has begun a system to obtain greater participation and involvement of contractor employees.

Recognizing that Kennedy operations are a team effort performed by some 2,000 civil service and 13,000 contractor personnel, the center has developed and published a Contractors' Integrated Suggestion System. Initiated Nov. 2, 1984, the system provides a means for employee suggestions submitted to contractor programs to be evaluated for application in another contractor's area or by NASA/KSC and, if adopted, provides a means for recognizing and awarding the contribution.

The new initiative is another part of center director Richard G. Smith's overall effort to increase productivity with a strong commitment to the Employee Suggestion Program. Before the agencywide effort officially began, Smith sent a letter to all Kennedy civil service employees, challenging them to improve efficiency and productivity by sharing their ideas. He committed Kennedy to support the program and emphasized the need to have all suggestions given fair and prompt evaluations. To augment these goals, each organization appointed a Suggestion Program Advocate to assure proper management emphasis and attention to the program.

In Fiscal Year 1984, Kennedy Space Center received nearly 250 suggestions compared to fewer than 50 in 1983. The processing time has decreased from six to nine months to five to six weeks. The adoption rate has increased from 5 percent in 1983 to approximately 25 percent in 1984 and, based upon suggestions recommended for adoption in 1984, the center should save more than $250,000 in 1985.

Many interesting ideas have been received and adopted. One suggester, William K. Lewis, an engineer in the Shuttle Management and Operations Directorate, redesigned the Air Data Transducer Assembly Manifold System for Shuttle testing to reduce test time and man hours necessary to perform tests. Lewis saved KSC nearly $3,000.

Several suggestions have been adopted dealing with cost avoidance. Emery Lamar, an engineer in the Shuttle Management and Operations Directorate, saved the government more than $16,500 with a procedure that eliminates the need to purchase temporary covers for the orbiter lift jack pits. In the STS Cargo Operations Directorate, engineer Ray Norman's suggestion saved $198,000 over a 10-year period by identifying spare parts, scheduled to be excessed by a contractor, as usable for the Ground Support Cooling Unit.

More than $40,000 in travel funds will be saved in 1985 due to the forward thinking of William B. Williams of the Shuttle Management and Operations Directorate. Williams recommended restructuring convoy simulation so that temporary duty time for Kennedy personnel deployed to Edwards Air Force Base in California was decreased.

Dolores Alexander, a payroll clerk in the Financial Management Office, suggested the telephone number of the timekeeper be placed on time and attendance cards. This makes it easier for payroll clerks to correct time and attendance information and saves time for the timekeeper, payroll clerk and keypunch operator.

A unique safety suggestion dealt with the use of metal staples in the Clean Room. Stanley Young, an engineer in the Engineering Development Directorate, was recognized for his constructive thinking and a potential safety hazard has been corrected by excluding metal staples and paper clips from the Clean Room environment.

In addition to tangible savings, a number of ideas dealing with employee morale and welfare were received. An 'Employee of the Month" award has been instituted. Recipients of this award are allotted a high visibility parking space for 30 days.

Kennedy employees with good ideas: (front row) Dolores Alexander and Ray Norman; (back row, from the left) Stanley Young, Emery Lamar, William K. Lewis and William B. Williams.

Contractor News

NASA has selected the **Boeing Computer Services Co.**, Vienna, Va., for negotiations leading to the award of a contract to provide program support communications for the agency. The contractor will provide hardware, software, documentation and transmission services required to deliver, install, operate and maintain a Program Support Communications Network and three Private Automatic Branch Exchanges (PABX) and the communications mission services to support the network and the PABX. Term of the contract, including priced and unpriced options, will be up to 10 years, with a proposed cost/price of approximately $205 million for the first five years. The contract will be a fixed-price lease with option to purchase the Program Support Communications Network, fixed-price lease to ownership for the PABX and a fixed-price requirements lease for the tarriffed transmission service. **Brown and Associates Management Services, Inc. (BAMSI)**, Titusville, Fla.; **RCA Services Co.**, Cherry Hill, N.J.; and **Teledyne Brown Engineering Corp.**, Huntsville, Ala., will support Boeing as subcontractors in the performance of the contract. The Program Support Communications will interconnect NASA Headquarters, field installations and major contractor locations for the transfer of programmatic and institutional data and voice. PABX will provide voice and data systems at Marshall Space Flight Center, Huntsville, Ala.; Michoud Assembly Facility, New Orleans; and Slidell Computer Complex, Slidell, La.

Kennedy Space Center has awarded **EG&G Florida, Inc.**, Cocoa, Fla., a one-year $90,433,613 extension to its existing contract for base operations services. The extension covers the period Jan. 1 through Dec. 31, 1985. This second one-year extension brings the cumulative cost of the original contract, awarded in January 1983, to $275,199,168. EG&G Florida is part of the Government Services Division of EG&G, Inc., Wellesley, Mass. Under terms of the contract extension,

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EG&G will continue to provide institutional and technical support services including utilities, facilities, administrative services, technical operations, and health and protective services at the center.

Marshall Space Flight Center has awarded a $2 million contract to **Teledyne Brown Engineering, Inc.**, Huntsville, Ala., to study aspects of an orbiting research facility. The two-year contract is for a basic conceptual study of equipment and other aspects of a pressurized microgravity materials sciences laboratory module to be orbited in space. Marshall is charged with management of the design of a "common" module, several of which would be used for the Space Station. This common module, with variations, would be designed for living quarters for the station crew; laboratory research and commercial manufacturing; and logistics — the storing of replenishable goods used by the crew, like water, food, clothing and oxygen. The Teledyne Brown study is to focus specifically upon the requirements that scientific research and commercial manufacturing will impose on the common module. The contract calls for the company to identify specific equipment and hardware that would go into the module; identify potential commercial research and development activities in which the module could be used; and establish operational requirements for the government, academic institutions and industry.

Goddard Space Flight Center has selected the **Rolm Corp.**, Tysons Corner, Va., for negotiation of a fixed-price contract for two telephone systems for use at the Greenbelt complex and at its Wallops Flight Facility, Wallops Island, Va. The agreement, consisting of a two-year basic period with four one-year options, is expected to cost $14 million for the five-year period. The contract will provide for the complete installation and maintenance of the voice and digital telecommunications at Greenbelt and Wallops. Currently, the two sites use different systems. This contract will develop a single system. The system changeover is expected to take one year.

Goddard also has selected **Computer Sciences Corp.**, Falls Church, Va., for negotiation of a contract for engineering services. Effective April 1, 1985, the cost-plus-award-fee contract consists of a two-year basic period with three one-year hard options. Additionally, a separate fixed price 45-day phase-in contract will be negotiated. Total proposed cost and fees for the basic two-year period and three one-year periods are $9.8 million and $15.7 million, respectively. The agreement will provide 166 personnel to support the Suborbital Projects and Operations Directorate at Wallops Flight Facility in the performance of instrumentation systems, mechanical systems, avionics and launch vehicle analysis, safety analysis, technical liaison and project management, technical editing, management data, facilities engineering, applied science, automatic data processing and metal trades and instrumentation construction.

Simple Changes to Light Plane Wing Increase Safety

Up to 20 percent of all fatal light airplane accidents may be preventable with a wing modification developed through NASA research.

The modification, a simple but effective reshaping of part of an airplane wing, is a product of several years of research at NASA's Langley Research Center, Hampton, Va., and Ames Research Center, Mountain View, Calif.

Wind tunnel and flight tests of the reshaped wings reveal greatly increased resistance to airplane spins, a potentially dangerous flight condition that can result from wing stall (loss of lift). Aircraft stalls sometimes occur during improper takeoff, landing and low-speed maneuvers.

"Light airplanes flying today are certified to federal aviation regulations — they are safe airplanes. NASA's goal is to make them safer," said Paul Stough of Langley's Flight Dynamics Branch. Present guidelines grant certification if a new airplane can be brought quickly under control after a one-turn spin. The Federal Aviation Administration is expected to decide in 1985 if special certification credit is to be issued for airplanes that are highly spin-resistant.

Langley is providing its research results to light aircraft manufacturers and to the FAA. NASA's approach to reducing the threat of spin in light planes has evolved to spin resistance, because light planes fly at lower altitudes with little time to recover.

"This wing modification," added Stough, "is something that prevents the pilot from going out of bounds, so to speak, but doesn't interfere with the normal utility of the airplane. The only performance penalty we've seen is a negligible loss of one to two miles-per-hour in cruise speed, a difference most pilots are not likely to notice."

The wing modification is a carefully designed "glove" placed over the outer portion of the wing leading edge, covering about the first six inches of the upper surface and the first 18 inches of the lower surface. The glove is lightweight, has no moving parts and requires no maintenance.

At the glove juncture, there is an abrupt transition from the original leading edge to the recontoured area. The glove extends about two inches forward of the original wing. The extended leading edge area is drooped and more rounded than usual with a flattened undersurface where it fairs into the original wing, as developed for the three airplanes flight tested to date.

"With this wing design, Langley research pilots have pressed their light planes to (wing) angles of attack almost twice as high as normal before encountering any spin tendency. When the airplane gets to about 18 degrees angle of attack, instead of stalling and departing from controlled flight, it gives the pilot indications that 'Hey, you shouldn't be operarting up here,' yet it must be pushed beyond about 35 degrees angle of attack before the airplane will actually depart," said Stough.

Before they were modified, the three test airplanes would enter a spin about 18 of every 20 times the wings were stalled and pro-spin controls were applied. With Langley's wing leading edge design, the same planes entered a spin only once in every 20 attempts. The spins that did occur required improper airplane loading or extremely aggravated inputs by the pilot. The pilot generally had three to four times as long — measured in seconds — to make a correction before the plane entered a spin. "The wing has greatly reduced the tendency for, and has given the pilot more time to take, corrective action those few times when it is needed," concluded Stough. "We're not saying this wing leading edge design is the only way to provide spin resistance. Someone else may come up with a simpler, better or just different means of achieving the same thing, but this is a simple solution that works now," he said.

NASA's ultimate goal is to provide airplane designers with the ability to incorporate the modification as an integral part of a wing, rather than an add-on, and to provide the analytical tools to determine the amount of spin resistance for new airplanes — generalizing the solution for all conventional light airplanes.

The research is being expanded beyond the present series of unswept, low-wing airplanes to include high-wing airplanes and those with different airfoil shapes.

The first use of a spin-resistant wing design is expected to be on a new airplane design, not a modification added to existing airplanes. Wind tunnel model tests have been conducted at Langley to ensure the concept's compatibility with one promising wing design concept, called natural laminar flow, that may set new efficiency standards for the next generation of light airplanes. The tests indicate that the new natural laminar flow (low-drag) wings can also incorporate Langley's spin-resistant "discontinuous wing" leading edges without losing their laminar (very smooth) air flow.

Modifications to Piper PA-28 Arrow for spin tests include tail-mounted spin-recovery parachute system and explosively-activated escape panel. The discontinuous drooped leading edge installed on the outboard wing section begins at mid wing.

Other wind tunnel work is proceeding for NASA at the University of Maryland, College Park, to define the exact flow mechanisms responsible for making a modified wing so much more spin resistant. Researchers know that, at high angles of attack, the abrupt transition between standard and modified wing regions creates a horizontal tornado-like flow called a vortex that acts like a wall to prevent stalled (separated) air at the wing root from disrupting the flow on the outer part of the wing. The drooped leading edge tends to keep the flow attached longer to the all-important wing tip areas.

NASA and India Sign Launch Agreement

NASA Administrator James M. Beggs and U. R. Rao, Chairman of the Indian Space Research Organization (ISRO), have signed a launch services agreement covering the reimbursable launch of the Indian National Satellite, INSAT 1C, scheduled for mid-1986 aboard the Space Shuttle.

INSAT 1C is a multipurpose satellite which will provide communications and meteorological services to India.

An ISRO scientist/engineer will serve as a payload specialist aboard the Shuttle during the INSAT 1C mission.

In addition to the signing, discussions were held regarding experiments which the Indian payload specialist would perform during the mission and potential cooperation between NASA and ISRO in the areas of space applications and space science.

JSC Public Information Chief Retires

John E. McLeaish, 55, Chief of the Johnson Space Center's Public Information Branch for the past 16 years, retired from NASA earlier this month.

McLeaish, who has directed around-the-clock news center operations for the last 29 manned space missions, has more than 30 years federal service.

McLeaish began his government service in 1952, serving as an Air Force navigator and information officer until 1959 when he joined a publishing firm in Dallas.

In 1961, he became information officer at Ellington Air Force Base, Texas, and the following year became an information specialist at the NASA Manned Spacecraft Center, Houston, now the Johnson Space Center. He served as Deputy Chief of Public Information until 1968 when he was named to his present position.

McLeaish served as NASA spokesman for the Apollo 11 crew following the first lunar landing mission. He has served as a mission control commentator for Gemini, Apollo, Skylab and Shuttle missions.

He was awarded the NASA Exceptional Service Medal for Skylab news operations and shared in the Presidential Medal of Freedom award with Mission Control personnel as the result of being mission commentator at the time of the Apollo 13 explosion.

NASA Recognizes Johns Hopkins Team for Medical Development

NASA has conferred the agency's Space Act Awards on four Johns Hopkins Applied Physics Laboratory personnel for the invention of a medical device based on space and aeronautics technology.

The invention, called a Programmable Implantable Medication System (PIMS), is a computerized pump that can be implanted in the human body to treat diseases by automatically dispensing medicine.

Recipients of the awards are Robert E. Fischell, Assistant Space Department Head and Chief of Technology Transfer; Wade E. Radford and Albert C. Sadilek, engineers in this department; Arthur F. Hogrefe, engineer in the Technical Services Department. All are employed at the Applied Physics Laboratory located in Laurel, Md.

The NASA Space Act Awards are given to NASA employees, contractor employees or other persons making a significant scientific or technical contribution to aeronautical or space activities.

The PIMS has numerous applications, including the treatment of diabetes, sex hormone dysfunctions cancer and cardiovascular problems, relief of spinal pain and many other uses where the dispensing of a precise amount of medication over a period of time is essential.

Medication is introduced to the reservoir located in the PIMS by a non-hypodermic (syringe) device so that its tiny, battery-powered pump can send the medication into the body via a tube in minute doses, which are precisely timed by one of two clocks within the PIMS. A small computer in the PIMS analyzes its performance and operates an alarm that notifies the patient via an electrical tickling of the skin if the device is malfunctioning or about to run out of fluid.

The PIMS was developed under the NASA Technology Utilization Applications Engineering Program. Among the NASA technologies employed in the PIMS development were space microcircuitry, titanium welding, the pump and fluid handling systems used on the Viking spacecraft and the techniques of quality control applied in the space program.

The PIMS has been licensed to Pacesetter Systems, Inc., Sylmar, Calif. It is projected that 300 units of the implantable system will be sold in 1985, 2,000 in 1986 and that ultimately 300,000 units will be manufactured and sold annually.

51-C Crew — The first dedicated Department of Defense Space Shuttle mission is scheduled for launch no earlier than Jan. 23. Crewmembers are astronauts Thomas K. Mattingly II, commander (kneeling right), and Loren J. Shriver, pilot (kneeling left). Standing (from the left) is U.S. Air Force payload specialist Gary E. Payton and mission specialists James F. Buchli and Ellison L. Onizuka.

1985 Launch Activity

Space Shuttle Launches

Date	Mission	Orbiter	Launch Site*	Remarks
Jan. 23	51-C	Discovery (OV-103)	KSC	Dedicated Department of Defense flight.
Feb. 20	51-E	Challenger (OV-099)	KSC	Payload: Telesat-I, TDRS-B.
March 19	51-D	Discovery (OV-103)	KSC	Payload: Syncom IV-3; LDEF-1 retrieval mission.
April 30	51-B	Challenger (OV-099)	KSC	Payload: Spacelab 3.
May 30	51-G	Discovery (OV-103)	KSC	Payload: Spartan-1, Telstar 3-D, Morelos-A, Arabsat-A.
July 9	51-F	Challenger (OV- 099)	KSC	Spacelab 2.

Satellite Deployments from the Shuttle

Date	Satellite	Upper Stage**	Shuttle Mission	Remarks
Feb. 20	TDRS-B	IUS/2	51-E	NASA communications.
Feb. 21	Telesat-I	PAM-D	51-E	Canadian communications.
March 20	Syncom IV-3	UUS	51-D	Hughes communications.
May 30	Morelos-A	PAM-D	51-G	Mexican communications.
May 31	Arabsat-A	PAM-D	51-G	Saudi Arabian communications.
June 1	Telstar 3-D	PAM-D	51-G	AT&T communications.

Expendable Launches

Date	Mission	Launch Vehicle	Launch Site*	Remarks
February	Intelsat VA-B	Atlas Centaur	ESMC	Intelsat communications.
1st Qtr.	AF-16	Scout	WFF	U.S. Air Force.
1st Qtr.	Navy-22	Scout	WSMC	U.S. Navy.
April	Intelsat VA-C	Atlas Centaur	ESMC	Intelsat communications.
2nd Qtr.	Navy-23	Scout	WSMC	U.S. Navy.
August	Intelsat VA-D	Atlas Centaur	WSMC	Intelsat communications.
August	NOAA-G	Atlas	WSMC	National Oceanic and Atmospheric Administration weather satellite.
3rd Qtr.	AF-17	Scout	WFF	U.S. Air Force.
October	GOES-G	Delta	ESMC	NOAA environmental satellite.
December	San Marco	Scout	SMR	NASA cooperative with Italy.
4th Qtr.	AF-18	Scout	WFF	U.S. Air Force.
4th Qtr.	FLTSATCOM	Atlas Centaur	ESMC	U.S. Navy-U.S. Air Force Fleet Satellite Communications.

* **Launch Sites:** KSC — Kennedy Space Center, Fla.; ESMC — Eastern Space and Missile Center, Fla.; SMR — San Marco Range, Indian Ocean; WSMC — Western Space and Missile Center, Vandenberg Air Force, Base, Calif.; WFF — Wallops Flight Facility, Wallops Island, Va.

** **Upper Stages:** IUS — Inertial Upper Stage; PAM-D — Payload Assist Module; UUS — Unique Upper Stage.

Another Dividened from Air and Space

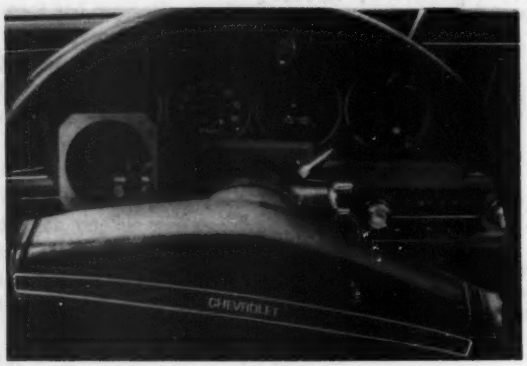
NASA
National Aeronautics and Space Administration

Research and development in aeronautics and space have provided numerous benefits for all Americans — and at a tiny percentage of the tax dollar. Here is an example:

Drunk Driver Testing

In the mid-1960s, preparing for long duration space missions of the future, NASA conducted a test — performed by McDonnell Douglas Astronautics Co. — in which four men were sealed in a realistically simulated space station for 90 days. The experiment had dual purpose: testing the components of an advanced life support system, and obtaining data on the physiological and psychological effects of long confinement. Of particular importance was measurement of the subjects' abilities to perform certain tasks and determination of how much their abilities were impaired by long term isolation. For these behavioral measurements, Ames Research Center, Mountain View, Calif., contracted with Systems Technology, Inc., Hawthorne, Calif. for preparation of a series of "tracking tasks" to be accomplished by the subjects and for development of an electronic system for analyzing and rating the subjects' visual/motor responses.

Almost two decades later, that technology has turned up in a system for determining whether a driver is too drunk to drive. Under contract to the National Highway Traffic Safety Administration (NHTSA) of the Department of Transportation, Systems Technology produced a variant of the NASA Critical Tracking Task (CTT) device, the testing component of a Drunk Driver Warning System (DDWS). Last year it was tested experimentally in California; in two of the state's counties, twice-convicted drunk drivers were given a choice of operating a DDWS-equipped test car for six months or taking an alternative sentence involving a fine and treatment.



The device is intended to discourage intoxicated drivers from taking to the road by advising them they are in no condition to operate a vehicle; if they drive anyway, the DDWS system warns police and other drivers. Mounted on the steering column directly in front of the driver, the CTT device tests eye-to-hand coordination and reaction time. When the driver turns on the ignition, the car's hazard lights start blinking; to turn them off he has to pass the test. The test involves watching a needle (above right) on the CTT and keeping it centered — by turning the steering wheel — for less than a minute. It sounds easy, but tests have shown a high failure rate for drivers with blood alcohol concentrations above 0.10 percent.

If the driver fails the test or does not take it and elects to drive anyway, the hazard lights will continue to flash on and off and, in addition, the horn will blow once every second, a clear signal to police and potential victims. In the California experiment, the test cars were also equipped with a monitor that recorded when the ignition was turned on, whether the driver passed the test, and whether the car was driven after a test failure, and at what speed. These records were studied by project personnel every two weeks and the performance of the drivers was analyzed. Study findings are being evaluated by NHTSA.

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* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.